PROCESS FOR PRODUCING A HOLLOW PROFILED SECTION

BACKGROUND AND SUMMARY OF THE INVENTION

[0001] The present invention relates to a process for producing a hollow profiled section, in particular an internal high-pressure forming process~~, in accordance with the preamble of claim 1~~.

[0002] The internal high-pressure forming process is used to produce hollow profiled sections or shell profiled sections in particular from sheet metal. In this case, either a sheet-metal blank is deformed to produce a half-shell or two sheet-metal blanks lying on top of one another, which have been welded at the edge sides, are widened to form a hollow profiled section. It is also standard practice for a metal sheet which has been bent to form a hollow profiled section that has been welded along a longitudinal seam to be introduced into an internal high-pressure forming (hydroforming) tool, in order then for an internal high pressure to be introduced into the hollow profiled section by means of a fluid, with the result that the hollow profiled section is then forced apart and comes to bear accurately against the contour of the hydroforming tool.

[0003] German Patent Document DE ~~De~~ 101 04 860 C1 has in this respect disclosed an internal high-pressure forming process, in which two metal sheets resting on top of one another are clamped between two blank holders, which are spaced apart from one another to form an expansion space. The expansion space is delimited at the top and bottom by two dies. A fluidic internal high pressure is introduced between the metal sheets, leading to expansion of the metal sheets. The dies are at different distances from the double metal sheet, with the metal

sheet located further away from the opposite die having curved formations. These curved formations form a reserve of material which allows the metal sheet to withstand the greater degree of deformation without being damaged. When the metal sheet is in contact with the surface of the associated die, the curved formations are smoothed by the internal high pressure in order to complete the forming of the metal sheet.

[0004] The component geometry which can be achieved for components deformed by internal high pressure is determined to a considerable extent by the maximum change in peripheral size which the component can undergo during the internal high-pressure forming.

[0005] This maximum permissible change in peripheral size is in turn defined by the maximum elongation at break of the material used for the component and the position of the shaping itself. In other words, the maximum achievable shaping in internal high-pressure forming is determined on the one hand by the maximum permissible change in peripheral size and on the other hand by the original size of the starting material.

[0006] If, for example, smooth, longitudinal seam welded tubes or hollow profiled sections are used as starting material, the dimension or diameter of the profiled sections or tubes is defined by the minimum component size, such that a plastic shape change is achieved in all regions of the component during the forming operation.

[0007] During manufacture of products of this type by means of internal high-pressure forming, however, one drawback is that in a large number of applications the maximum achievable shaping is approximately 100% utilized, which leads to a high scrap rate, entailing considerable costs.

[0008] In the automotive engineering industry, it is desirable for structural components to satisfy high demands both with regard to strength and with regard to rigidity. Furthermore, there is considerable interest in realizing lightweight designs in vehicle construction and therefore reducing the weight of these parts to the maximum possible extent.

[0009] This is generally achieved by virtue of the fact that, with a simultaneous reduction in weight, the starting material used is thin metal sheets made from high-strength steels, which have a comparable strength to thicker sheets of conventional steels. The required rigidity, however, is then effected by rigidity-increasing structures, such as for example elevations or bulges and/or depressions in the surface of the component, at least in regions which in subsequent use are exposed to high stresses.

[0010] For various strength and design reasons, however, it is also desirable for structured profiled sections to be produced by means of internal high-pressure forming for more complex products than hitherto, which in particular also satisfy the demands imposed by lightweight construction. In this context, in particular the frame structural components of the vehicle body are of particular interest.

[0011] Working on this basis, the object of the present invention is to produce components of more complex configuration by means of the internal high-pressure forming process, which have the required strength and rigidity properties, without having to completely utilize the maximum achievable degree of shaping, with the associated high scrap rates.

~~**[0012]** This object is achieved by the features of patent claim 1.~~

[0013] ~~Accordingly, the~~ The invention relates to a process for producing a hollow profiled section, the latter being shaped out of at least one metal sheet by

fluidic high pressure. Prior to the shaping operation, the surface of the metal sheet is provided with structure elements in the form of depressions and/or elevations.

[0014] To form a curve-structured metal sheet of this type, according to the invention the number, dimensions and contours of the structure elements are deliberately fixed as a function of the properties to be achieved by the component to be produced in this way, so that during the subsequent application of fluidic high pressure the maximum permissible change in peripheral size for the component is complied with and the maximum degree of shaping is increased.

[0015] This type of ratio also allows internal high-pressure forming in which the maximum degree of shaping is complied with, so that the change in peripheral size, if desired, can be reduced.

[0016] The process according to the invention is distinguished by the advantage that by increasing the degree of shaping which can be achieved in a component produced for example by hydroforming, this component can be configured with a more favorable design with a view to its subsequent use, in particular with regard to the rigidity and strength properties, for example in respect of the ability to absorb forces, since structured profiled sections of this type can be realized more easily in conjunction with the cold work-hardening which is associated with the internal high-pressure forming process.

[0017] By way of example, the process according to the invention can be used in particular to produce supports for the body of a motor vehicle which satisfy the demands of lightweight construction to a high degree.

[0018] The contour of the structure elements in the form of depressions and/or elevations can in principle be selected as desired. During production of these elements, for example by stamping or rolling the sheet metal surface, it is merely

necessary to ensure that the stretching of the material in the edge regions of the structure elements is minimized.

[0019] According to the invention, therefore, the insertion profile of the component to be deformed, i.e. the contour of the metal sheet which is inserted into the forming tool prior to the widening operation, by virtue of the presence of structure elements, is provided with an increased size. This larger size as it were provides a deformation reserve by providing a larger effective surface area.

[0020] In this context, during forming using fluidic high pressure, a higher degree of cold work-hardening can then be achieved in the regions with a smaller size of the components.

[0021] It is known that a further influencing variable, in particular with respect to the hydroforming process, is the friction between the work piece and the forming tool during the forming operation. Hitherto, it has been attempted, inter alia, to minimize the friction by providing a corresponding coating on the surface of the starting material.

[0022] The new type of configuration of the metal sheet used with structure elements also makes it possible for at least some of the structure elements, during insertion of the metal sheet into the forming tool, to partially form cavities with respect to the inner surface of the forming tool in order to hold a lubricant which keeps the friction between the inner surface and the metal sheet at a low level. This likewise results in an increase in the maximum permissible change in peripheral size.

[0023] Depending on the component which is to be produced, it may be desirable for the structure elements to be retained in those regions of the component which are exposed to high stresses, so as to effect increased rigidity in the completed component. For this purpose, during the deformation of the metal

sheet used to form the hollow profiled section, the structure elements are at least partially retained on the surface of the metal sheet, which can be achieved by suitably configuring the contours of the inner surface of the forming tool.

BRIEF DESCRIPTION OF THE DRAWING

[0024] Fig. 1 shows by way of example an excerpt from a metal sheet which is to be used in the process according to the invention.

DETAILED DESCRIPTION OF THE DRAWING

[0025] The metal sheet 1 has a plurality of structure elements 2 in the form of elevations or curved formations distributed uniformly.

[0026] The metal sheet 1 is then bent to form a, for example, rotational symmetrical tubular semi-finished hollow profiled section and is welded at the abutting surfaces along a longitudinal seam to form this semi-finished hollow profiled section, so that structure elements 2 in the form of curved formations of this type are provided over the entire periphery of the semi-finished hollow profiled section.

[0027] The structure elements 2 are in particular circle-symmetrical, so that the stretching of the material in the edge region of the curved formations 2 is minimized.

[0028] Then, the semi-finished hollow profiled section is widened by means of internal high pressure in an internal high-pressure forming tool to produce the hollow profiled section.

[0029] Alternatively, it is conceivable for the hollow profiled section to be formed from two metal sheets 1, which are first of all placed on top of one another and then clamped inside an internal high-pressure forming tool. Then, a pressurized fluid is introduced between the metal sheets, which by exerting an internal high pressure by means of the pressurized fluid are spread open and widened to form the hollow profiled section.

[0030] In a further variant of the invention, as a deviation from the first exemplary embodiment mentioned above, the semi-finished hollow profiled section, after the longitudinal seam welding, in an external high-pressure forming tool is shaped to form the hollow profiled section by interaction of a fluidic high pressure directed from the outside inward with a die that has been introduced in the interior of the semi-finished hollow profiled section, the semi-finished hollow profiled section being pressed accurately in terms of contours onto the die, the shape and contours of which represent an image of the hollow profiled section.

[0031] In all the exemplary embodiments, the metal sheets 1, the shaping of which leads to the desired hollow profiled section, have structure elements 2 in the form of curved formations.